

PATENT ABSTRACTS OF JAPAN

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(21)Application number : 07-169985

(71)Applicant : RICOH CO LTD

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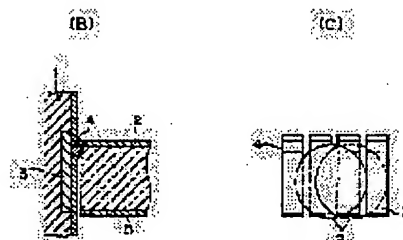
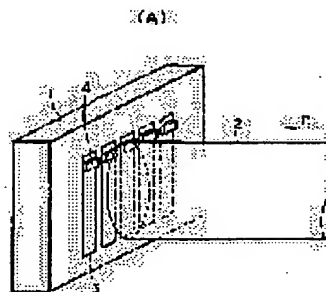
(72)Inventor : KATO MASAYOSHI

(54) OPTICAL MODULE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an optical module with which the accuracy of alignment of an optical fiber and photodetectors is relieved without degrading the performance of an optical module consisting of the optical fiber and the photodetectors, the simultaneous attainment of optical coupling and electrical coupling is possible and production is easy.

SOLUTION: A photodetector substrate 1 is arranged with the photodetectors consisting of photodetecting regions 3 having the size approximately equal to or smaller than the outside diameter of the optical fiber 2 and at least ≥ 1 projecting electrodes 4 for the photodetecting regions 3 in an array form. The end face and outer peripheral part of the optical fiber 2 are partly subjected to conductive coating 5. The optical fiber 2 is brought near to the photodetector substrate 1 in such a manner that the exit light from the optical fiber 2 is made incident on the photodetecting regions 3 and the conductive coating 5 and the projecting electrodes 4 are brought into contact with each other to attain electrical connection, by which the optical coupling and the electrical coupling are simultaneously attained.



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JAPANESE

[JP,09-021932,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS
DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

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CLAIMS

[Claim(s)]

[Claim 1] It is the optical module which consists of at least one or more optical fibers and photo detectors. To the photo detector substrate arranged in the shape of an array, the photo detector which consists of an electrode which has [as opposed to / comparable / as the outer diameter of said optical fiber / or / a light-receiving field smaller than it and this light-receiving field] at least one or more heights The optical module characterized by being constituted so that this optical fiber that gave conductive covering to the end face of said optical fiber and a part of periphery section may be made to approach, the electrode which has said conductive covering and said heights may be contacted and electric connection may be taken.

[Claim 2] The optical module according to claim 1 characterized by having the monotonous substrate which has the slot where the electrode was formed in at least one or predetermined spacing corresponding to said optical fiber, and fixing said optical fiber so that connection with said electric conductive covering and electrode of said slot may be taken by said Mizouchi.

[Claim 3] The optical module according to claim 1 characterized by having protection heights to said a part of light-receiving field so that the joint material when joining the electrode which has said conductive covering and said heights may not permeate inside [end-face] an optical fiber.

[Claim 4] The optical module according to claim 1 characterized by arranging so that said photo detector and said optical fiber may be pressurized and it may join together.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the optical module which can be applied to optical communication, optical information processing, an optical interconnection, etc. at a detail more about an optical transmission module.

[0002]

[Description of the Prior Art] The optical module is proposed as well-known reference which indicated the conventional technique concerning this invention by the "prototype of the many channels LD and PD array module" (trinominal outside Moriya scent, 1992 Institute of Electronics, Information and Communication Engineers spring convention, C-269, P4-311) which can be illustrated. The thing of this reference mounts PD (photodiode) in the side face of the member for light corpuscle child immobilization, is arranged through the fiber and lens which were fixed to silicon V Mizogami, and has the structure fixed after adjusting an optical axis using the block for adjustment immobilization.

[0003] Drawing 5 is drawing showing the optical module (PD array module) indicated by said reference, and, for a lens array and 23, as for PD array and 25, a tape fiber and 24 are [21 / a carrier and 22 / the block for adjustment immobilization and 26] SiV slot fiber alignment members among drawing. The tape fiber 23 is arranged to the precision by the V groove formed at equal intervals in the anisotropic etching of silicon. Moreover, the lens array which integrated the micro lens to the monolithic is used for the lens array 22.

[0004] Drawing 6 is drawing showing other examples (refer to JP,5-37004,A) of the optical coupling of the conventional optical fiber and a photo detector, and the crevice 30 is formed so that the point of an optical fiber 36 may be held in the part corresponding to said light sensing portion 34 of the semi-conductor substrate 35 with which the light sensing portion 34 which consists of a buffer layer 31, a light absorption layer 32, and a gap layer 33 is formed. It positions by inserting an optical fiber 36 in this crevice 30, and optical coupling is made easy. And as for the electrical coupling to the circuit of the next step of a photo detector, in the conventional optical transmission module, it is common to carry out apart from optical coupling.

[0005]

[Problem(s) to be Solved by the Invention] It is necessary to perform optical-axis adjustment for every module, and a productivity issue remains with a configuration which finishes on an accommodation block setting up the photo detector shown in drawing 5, and an optical fiber according to an individual. Moreover, the problem of becoming large also has the module itself. Moreover, by the approach of carrying out crevice formation and performing alignment with a fiber to the substrate shown in drawing 6 in self align, there are troubles — a production process becomes complicated and causes cost rises, such as a fall of the yield. Furthermore, in a Prior art, before mounting an optical fiber, connection which connects the electrode of a photo detector with behind in the electrical circuit of the next step must be performed apart from optical coupling.

[0006] Without reducing the engine performance of the optical module which was made in view of the actual condition like ****, and consists of an optical fiber and a photo detector, it is possible to ease the precision of the alignment of an optical fiber and a photo detector, and to attain optical coupling and electrical coupling to coincidence, and this invention aims at offering the easy optical module of production.

[0007]

[Means for Solving the Problem] In order that this invention may solve the above-mentioned technical problem, among this inventions invention according to claim 1 Are the optical module which consists of at least one or more optical fibers and photo detectors, and comparable [as the outer diameter of said optical fiber] or A light-receiving field smaller than it, To the photo detector substrate arranged in the shape of an array, the photo detector which consists of an electrode which has at least one or more heights to this light-receiving field This optical fiber that gave conductive covering to the end face of said optical fiber and a part of periphery section is made to approach. When it is constituted so that the electrode which has said conductive covering and said heights may be contacted and electric connection may be taken, and making an optical fiber correspond to a photo detector, since said convex polar zone and said conductive covering are contacted, optical coupling becomes easy, and connection to the electrode of a photo detector is performed to coincidence.

[0008] Moreover, among this inventions, in claim 1, it has the monotonous substrate which has the slot where the electrode was formed in at least one or predetermined spacing corresponding to said optical fiber, said optical fiber is fixed so that connection with said electric conductive covering and electrode of said slot may be taken by said Mizouchi, and invention according to claim 2 makes easy connection with the electrical circuit of the next step.

[0009] Moreover, invention according to claim 3 has protection heights to said a part of light-receiving field in claim 1, and it is made for the joint material when joining the electrode which has said conductive covering and said heights not to permeate inside [end-face] an optical fiber among this inventions.

[0010] Moreover, among this inventions, in claim 1, invention according to claim 4 is arranged so that said photo detector and said optical fiber may be pressurized and it may join together, and it contacts a convex electrode and conductive covering certainly.

[0011]

[Embodiment of the Invention] Below, the optical module by this invention is explained based on the gestalt of operation. Drawing 1 (A) - drawing 1 (C) are the important section schematic diagrams of the optical module of the gestalt of operation by this invention, and drawing 1 (A) is [the sectional view of the bond part of a photo detector and an optical fiber and drawing 1 (C) of the perspective view of the bond part of a photo detector and an optical fiber and drawing 1 (B)] the direction top views of C line of

drawing 1 (A).

[0012] As shown in drawing 1, by the optical module by this invention the photo detector substrate 1 The electrode 4 which has [as opposed to / comparable / as the outer diameter of an optical fiber 2 / or / the light-receiving field 3 smaller than it and said light-receiving field 3] at least one or more heights (It considers as the convex electrode 4 hereafter) from — the becoming photo detectors (for example, photodiode of the pin structure produced on a silicon crystal substrate etc.) are arranged in the shape of an array, and said optical fiber 2 has given conductive covering 5 (a metal thin film, transparent electrode film, etc.) to a part of end face and periphery section. And it is made to approach so that at least one or more optical fibers 2 may be made the photo detector substrate 1 and incidence of the outgoing radiation light from this optical fiber may be made to said light-receiving field 3, and it is constituted so that optical coupling and electrical coupling can be attained to coincidence, as said conductive covering 5 and said convex electrode 4 are contacted and electric connection is taken.

[0013] That is, by the above-mentioned configuration, since the outgoing radiation light from an optical fiber will choose the photo detector near the optical axis of this optical fiber with which said convex electrode 4 comes to contact the covering 5 of the end face of an optical fiber 2, and the periphery section in self align, optical-axis adjustment with an optical fiber 2 and a photo detector serves as needlessness (alignment free-lancer) in the array direction of a photo detector, and it can simplify a module production process.

[0014] Drawing 2 (A) and (B) are the schematic diagrams of the optical module of the gestalt of operation by other invention of this application, drawing 2 (A) is the side elevation of drawing 2 (B), and drawing 2 (B) is the top view of drawing 2 (A). In case it actually attaches as a receiving module to some equipments, an optical module is electrically connected to the surrounding electronic-circuitry substrate 11 through the fiber attachment component 12. In the gestalt of this operation, Si crystal substrate is used for the fiber attachment component 12, the V groove for fiber maintenance is formed in this substrate by technique, such as anisotropic etching, patterning is performed by the lift-off method etc. into each slot, an electrode 14 is produced into it, an optical fiber 2 is fixed to said V groove with conductive adhesives, conductive solder, etc., electrical connection is performed, and this fiber attachment component 12 and the substrate 11 with which the electrical circuit of the next step is formed are connected in the wire-bonding 13 grade.

[0015] Drawing 3 (A) and (B) are the important section schematic diagrams for explaining the gestalt of operation by invention of further others of this application, drawing 3 (A) is the direction top view of A line of drawing 3 (B), and drawing 3 (B) is the B-B line sectional view of drawing 3 (A). When the protection heights 15 use bumps, such as conductive adhesives and solder, for said convex electrode 4, they are formed in the photo detector side so that it may prevent that the electrode member permeates between the core of a fiber, and a light-receiving side, and intercepts signal light. The formation approach of these protection heights 15 has the approach of forming with resin, an oxide film, etc. by patterning by the resist; or the approach by usual thin film coating technology and a usual photolithography technique.

[0016] Drawing 4 is a side elevation for explaining the gestalt of operation by invention of further others of this application. The conductive member 16 which is rich in elasticity with the gestalt of this operation between the electrical installation to the next step circuit on the circuit board 11 of rear-face electrode 1b of a photo detector, and the circumference and an optical fiber, and the metal member 10 of the L character mold which served as the member for the pressurization of a photo detector Since the photo detector substrate 1 can be pressurized and arranged to an optical fiber 2 by having (for example, the member which covered the metal thin film to the resin member), said convex electrode 4 and said covering 5 surely come to contact, and can ensure electric connection.

[0017] Various deformation is possible for this invention, without in addition to this deviating to this pneuma not only in an above-mentioned configuration and an above-mentioned approach.

[0018]

[Effect of the Invention]

Effectiveness corresponding to claim 1 : the photo detector which consists of a convex electrode [as opposed to / comparable / as the outer diameter of an optical fiber / or / a light-receiving field smaller than it and said light-receiving field] to the photo detector substrate arranged in the shape of an array By approaching the optical fiber which gave conductive covering to the end face of an optical fiber, and a part of periphery section, and contacting said convex electrode and said conductive covering Since the precision of alignment could be eased and optical coupling and ejection of a photo detector electrode were performed to coincidence, without carrying out performance degradation of the optical module which consists of an optical fiber and a light corpuscle child, it became possible to offer the easy optical module of production.

Effectiveness corresponding to claim 2: By fixing said optical fiber to this slot of the monotonous substrate which has the slot where the electrode is given, the connection with the electrical circuit of the next step became easy, and it became possible to offer a cheap optical module.

Effectiveness corresponding to claim 3: Since it had protection heights to said light-receiving field, the conductive member of said convex electrode and adhesives became possible [preventing permeating between the core section of an optical fiber, and a light-receiving field], and became possible [producing the good module of the yield].

Effectiveness corresponding to claim 4: In order that a convex electrode and conductive covering might contact certainly by pressurizing and arranging a photo detector substrate to an optical fiber, it became possible to ensure electric connection.

[Translation done.]

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TECHNICAL FIELD

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PRIOR ART

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EFFECT OF THE INVENTION

[Effect of the Invention]

Effectiveness corresponding to claim 1 : the photo detector which consists of a convex electrode [as opposed to / comparable / as the outer diameter of an optical fiber / or / a light-receiving field smaller than it and said light-receiving field] to the photo detector substrate arranged in the shape of an array By approaching the optical fiber which gave conductive covering to the end face of an optical fiber, and a part of periphery section, and contacting said convex electrode and said conductive covering Since the precision of alignment can be eased and optical coupling and ejection of a photo detector electrode can be performed to coincidence, without carrying out performance degradation of the optical module which consists of an optical fiber and a light corpuscle child It became possible to offer the easy optical module of production.

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Effectiveness corresponding to claim 4: In order that a convex electrode and conductive covering might contact certainly by pressurizing and arranging a photo detector substrate to an optical fiber, it became possible to ensure electric connection.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] It is necessary to perform optical-axis adjustment for every module, and a productivity issue remains with a configuration which finishes on an accommodation block setting up the photo detector shown in drawing 5, and an optical fiber according to an individual. Moreover, the problem of becoming large also has the module itself. Moreover, by the approach of carrying out crevice formation and performing alignment with a fiber to the substrate shown in drawing 6 in self align, there are troubles — a production process becomes complicated and causes cost rises, such as a fall of the yield. Furthermore, in a Prior art, before mounting an optical fiber, connection which connects the electrode of a photo detector with behind in the electrical circuit of the next step must be performed apart from optical coupling.

[0006] Without reducing the engine performance of the optical module which was made in view of the actual condition like ***, and consists of an optical fiber and a photo detector, it is possible to ease the precision of the alignment of an optical fiber and a photo detector, and to attain optical coupling and electrical coupling to coincidence, and this invention aims at offering the easy optical module of production.

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MEANS

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[0008] Moreover, among this inventions, in claim 1, it has the monotonous substrate which has the slot where the electrode was formed in at least one or predetermined spacing corresponding to said optical fiber, said optical fiber is fixed so that connection with said electric conductive covering and electrode of said slot may be taken by said Mizouchi, and invention according to claim 2 makes easy connection with the electrical circuit of the next step.

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[0010] Moreover, among this inventions, in claim 1, invention according to claim 4 is arranged so that said photo detector and said optical fiber may be pressurized and it may join together, and it contacts a convex electrode and conductive covering certainly.

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[0013] That is, by the above-mentioned configuration, since the outgoing radiation light from an optical fiber will choose the photo detector near the optical axis of this optical fiber with which said convex electrode 4 comes to contact the covering 5 of the end face of an optical fiber 2, and the periphery section in self align, optical-axis adjustment with an optical fiber 2 and a photo detector serves as needlessness (alignment free-lancer) in the array direction of a photo detector, and it can simplify a module production process.

[0014] Drawing 2 (A) and (B) are the schematic diagrams of the optical module of the gestalt of operation by other invention of this application, drawing 2 (A) is the side elevation of drawing 2 (B), and drawing 2 (B) is the top view of drawing 2 (A). In case it actually attaches as a receiving module to some equipments, an optical module is electrically connected to the surrounding electronic-circuitry substrate 11 through the fiber attachment component 12. In the gestalt of this operation, Si crystal substrate is used for the fiber attachment component 12, the V groove for fiber maintenance is formed in this substrate by technique, such as anisotropic etching, patterning is performed by the lift-off method etc. into each slot, an electrode 14 is produced into it, an optical fiber 2 is fixed to said V groove with conductive adhesives, conductive solder, etc., electrical connection is performed, and this fiber attachment component 12 and the substrate 11 with which the electrical circuit of the next step is formed are connected in the wire-bonding 13 grade.

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photo detector substrate 1 can be pressurized and arranged to an optical fiber 2 by having (for example, the member which covered the metal thin film to the resin member), said convex electrode 4 and said covering 5 surely come to contact, and can ensure electric connection.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the important section schematic diagram of the optical module by the gestalt of operation of this invention.

[Drawing 2] It is the schematic diagram of the optical module by the gestalt of implementation of other invention of this application.

[Drawing 3] It is an important section schematic diagram for explaining the gestalt of operation by invention of further others of this application.

[Drawing 4] It is a side elevation for explaining the gestalt of operation by invention of further others of this application.

[Drawing 5] It is an example of the optical coupling of the conventional optical fiber and a photo detector.

[Drawing 6] They are other examples of the optical coupling of the conventional optical fiber and a photo detector.

[Description of Notations]

1 [— The convex polar zone, 5 / — Conductive covering, the metal member of a 10—L character mold 11 / — A substrate, 12 / — A fiber attachment component, 13 / — Wire bonding, 14 / — The electrode of a V groove, 15 / — Protection heights, 16 / — Conductive member which is rich in elasticity.] — A photo detector substrate, 2 — An optical fiber, 3 — A light-receiving field, 4

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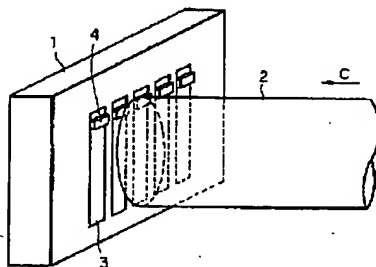
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DRAWINGS

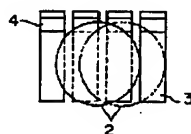
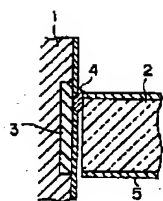
[Drawing 1]

(A)



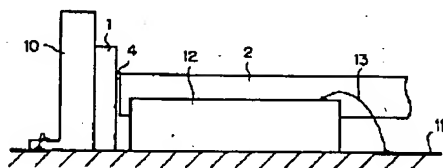
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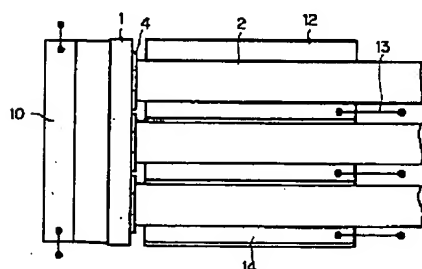


[Drawing 2]

(A)

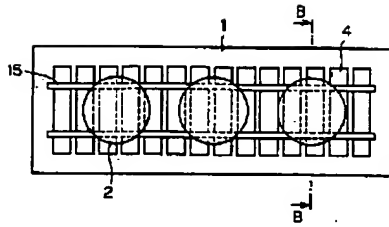


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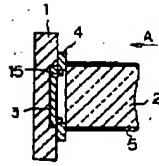


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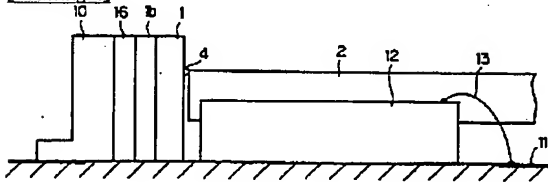
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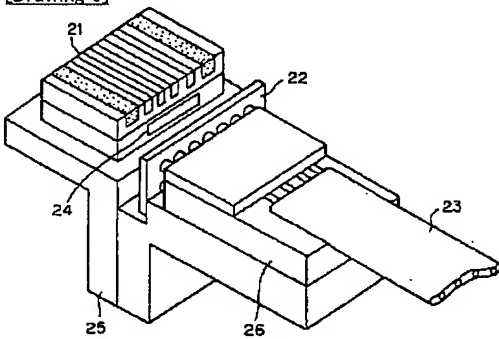
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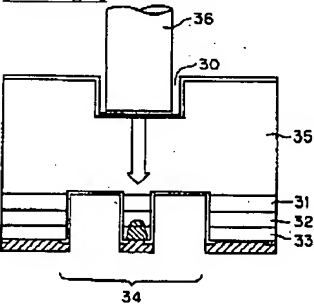
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]

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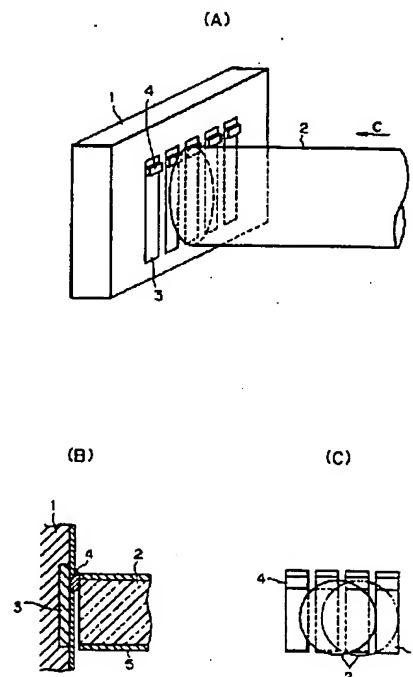
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(54) 【発明の名称】 光モジュール

(57) 【要約】

【課題】 光ファイバと受光素子とからなる光モジュールの性能を低下させることなく、光ファイバと受光素子との位置合わせの精度を緩和し、また、光学的結合と電気的結合を同時に達成することが可能で、作製の容易な光モジュールを提供することを目的とする。

【解決手段】 受光素子基板1は、光ファイバ2の外径と同程度かそれより小さい受光領域3と、前記受光領域3に対し少なくとも1つ以上あるの凸電極4とからなる受光素子をアレイ状に配置してあり、前記光ファイバ2は、端面及び外周部の一部に導電性の被覆5を施してある。そして、受光素子基板1に光ファイバ2を該光ファイバからの出射光を前記受光領域3に入射するように近接させ、前記導電性の被覆5と前記凸電極4とを接触させて電気的な接続をとるようにして光学的結合と電気的結合を同時に達成できるよう構成されている。



【特許請求の範囲】

【請求項 1】 少なくとも 1 つ以上の光ファイバと受光素子とからなる光モジュールであって、前記光ファイバの外径と同程度かそれより小さい受光領域と該受光領域に対し少なくとも 1 つ以上の凸部を有する電極とからなる受光素子をアレイ状に配置した受光素子基板に、前記光ファイバの端面及び外周部の一部に導電性の被覆を施した該光ファイバを近接させ、前記導電性の被覆と前記凸部を有する電極とを接触させて電気的な接続をとるよう構成されたことを特徴とする光モジュール。

【請求項 2】 前記光ファイバに対応した少なくとも 1 つもしくは所定間隔に電極が形成された溝を有する平板基板を有し、前記光ファイバを前記溝内で前記導電性の被覆と前記溝の電極とが電気的な接続をとるよう固定されたことを特徴とする請求項 1 に記載の光モジュール。

【請求項 3】 前記導電性の被覆と前記凸部を有する電極を接合するときの接合部材が光ファイバの端面内側に浸入しないよう、前記受光領域の一部に防護凸部を有したことを特徴とする請求項 1 に記載の光モジュール。

【請求項 4】 前記受光素子と前記光ファイバとを加圧し結合するように配置してあることを特徴とする請求項 1 に記載の光モジュール。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、光伝送モジュールに関し、より詳細には、光通信、光情報処理及び光インターコネクションなどに適用し得る光モジュールに関する。

【0002】

【従来の技術】 本発明に係る従来技術を記載した公知文献として、例示し得る「多チャンネル LD、PD アレイモジュールの試作」(守谷 薫 外 3 名、1992 年電子情報通信学会春季大会、C-269、P4-311) に光モジュールが提案されている。この文献のものは、光素子固定用部材の側面に PD (フォトダイオード) を実装し、シリコン V 溝上に固定されたファイバとレンズを介して配置され、調整固定用ブロックを用いて光軸を調整した後に固定する構造を有するものである。

【0003】 図 5 は、前記文献に記載されている光モジュール (PD アレイモジュール) を示す図で、図中、21 はキャリア、22 はレンズアレイ、23 はテープファイバ、24 は PD アレイ、25 は調整固定用ブロック、26 は Si V 溝ファイバ整列部材である。テープファイバ 23 は、シリコンの異方性エッチングにて等間隔に形成された V 溝で精密に配列している。またレンズアレイ 22 は、マイクロレンズをモノリシックに集積化したレンズアレイを用いている。

【0004】 図 6 は、従来の光ファイバと受光素子との光結合の他の例 (特開平 5-37004 号公報参照) を

示す図で、凹部 30 は、バッファ層 31 と光吸収層 32 とギャップ層 33 とからなる受光部 34 が形成されている半導体基板 35 の前記受光部 34 に対応する部分に光ファイバ 36 の先端部を収容するように形成してある。この凹部 30 に光ファイバ 36 を挿入することにより位置決めを行ない、光結合を容易にしている。そして、従来の光伝送モジュールにおいて、受光素子の次段の回路への電気的結合は、光結合とは別に行うことが一般的である。

【0005】

【発明が解決しようとする課題】 図 5 に示した受光素子と光ファイバとを調節ブロック上に個別に組み上げるような構成では、光軸調整をモジュール毎に行う必要があり生産性の問題が残る。また、モジュール自体が大きくなってしまふなどの問題もある。また、図 6 に示した基板に凹部形成してファイバとのアライメントを自己整合的に行う方法では、作製プロセスが複雑になり歩留まりの低下などコストアップの要因になる等問題点がある。更に、従来の技術では、光ファイバを実装する前、または、後に、受光素子の電極を次段の電気回路につなぐ結線を光結合とは別に行わなければならない。

【0006】 本発明は、上述のごとき実情に鑑みてなされたもので、光ファイバと受光素子とからなる光モジュールの性能を低下させることなく、光ファイバと受光素子との位置合わせの精度を緩和し、また、光学的結合と電気的結合を同時に達成することが可能で、作製の容易な光モジュールを提供することを目的とする。

【0007】

【課題を解決するための手段】 本発明は、上記課題を解決するために、本発明のうち請求項 1 に記載の発明は、少なくとも 1 つ以上の光ファイバと受光素子とからなる光モジュールであって、前記光ファイバの外径と同程度かそれより小さい受光領域と、該受光領域に対し少なくとも 1 つ以上の凸部を有する電極とからなる受光素子をアレイ状に配置した受光素子基板に、前記光ファイバの端面及び外周部の一部に導電性の被覆を施した該光ファイバを近接させ、前記導電性の被覆と前記凸部を有する電極とを接触させて電気的な接続をとるよう構成され、受光素子に光ファイバを対応させるときに、前記凸電極部と前記導電性の被覆とを接触させるので光結合が容易になり、同時に、受光素子の電極に対する結線を行う。

【0008】 また、本発明のうち請求項 2 に記載の発明は、請求項 1 において、前記光ファイバに対応した少なくとも 1 つもしくは所定間隔に電極が形成された溝を有する平板基板を有し、前記光ファイバを前記溝内で前記導電性の被覆と前記溝の電極とが電気的な接続をとるよう固定され次段の電気回路との接続を容易にする。

【0009】 また、本発明のうち請求項 3 に記載の発明は、請求項 1 において、前記受光領域の一部に防護凸部

を有し、前記導電性の被覆と前記凸部を有する電極を接合するときの接合部材が光ファイバの端面内側に浸入しないようにする。

【0010】また、本発明のうち請求項4に記載の発明は、請求項1において、前記受光素子と前記光ファイバとを加圧し結合するように配置し、凸電極と導電性の被覆とを確実に接触させる。

【0011】

【発明の実施の形態】以下に、本発明による光モジュールについて、実施の形態をもとに説明する。図1(A)～図1(C)は、本発明による実施の形態の光モジュールの要部概略図で、図1(A)は受光素子と光ファイバの結合部の斜視図、図1(B)は受光素子と光ファイバの結合部の断面図、図1(C)は図1(A)のC線方向平面図である。

【0012】本発明による光モジュールでは、図1に示したように、受光素子基板1は、光ファイバ2の外径と同程度かそれより小さい受光領域3と、前記受光領域3に対し少なくとも1つ以上の凸部を有する電極4(以下、凸電極4とする)とからなる受光素子(例えばシリコン結晶基板上に作製されるpin構造のフォトダイオード等)をアレイ状に配置してあり、前記光ファイバ2は、端面及び外周部の一部に導電性の被覆5(金属薄膜や透明電極膜等)を施してある。そして、受光素子基板1に少なくとも1つ以上の光ファイバ2を該光ファイバからの出射光を前記受光領域3に入射するように近接させ、前記導電性の被覆5と前記凸電極4とを接触させて電気的な接続をとるようにして光学的結合と電気的結合を同時に達成できるよう構成されている。

【0013】すなわち、上記構成により、光ファイバからの出射光は、光ファイバ2の端面及び外周部の被覆5に前記凸電極4が接触するようになる該光ファイバの光軸付近の受光素子を自己整合的に選択することになるので、光ファイバ2と受光素子との光軸調整が受光素子の配列方向には不要(アライメントフリー)となり、モジュール作製工程を簡略化できる。

【0014】図2(A)、(B)は、本願の他の発明による実施の形態の光モジュールの概略図で、図2(A)は図2(B)の側面図、図2(B)は図2(A)の平面図である。実際に装置の一部に受信モジュールとして組み付ける際は、光モジュールは、周辺の電子回路基板11にファイバ保持部材12を介して電気的に接続される。本実施の形態では、ファイバ保持部材12にSi結晶基板を使用し、該基板にファイバ保持用V溝を異方性エッチングなどの手法により形成し、各溝に電極14をリフトオフ法などによりパターニングを行って作製して、光ファイバ2を前記V溝に導電性の接着剤やはんだ等によって固定して電気接続を行い、このファイバ保持部材12と次段の電気回路が形成されている基板11とをワイヤーボンディング13等で接続してある。

【0015】図3(A)、(B)は、本願の更に他の発明による実施の形態を説明するための要部概略図で、図3(A)は図3(B)のA線方向平面図、図3(B)は図3(A)のB-B線断面図である。防護凸部15は、例えば前記凸電極4に導電性の接着剤やはんだなどのバンプを用いた際に、その電極部材がファイバのコアと受光面の間に浸入して信号光を遮断することを防止するように、受光素子面に形成してある。この防護凸部15の形成方法は、レジストによるパターニングや通常の薄膜形成技術とフォトリソグラフィ技術による方法によって樹脂や酸化膜等で形成する方法がある。

【0016】図4は、本願の更に他の発明による実施の形態を説明するための側面図である。本実施の形態では、受光素子の裏面電極1bと周辺の回路基板11上の次段回路への電気的接続および光ファイバと受光素子の加圧用の部材を兼ねたL字型の金属部材10との間に弾性に富む導電性部材16(例えば、樹脂部材に金属薄膜を被覆した部材)を有することにより、光ファイバ2に対し受光素子基板1を加圧して配置できるので、前記凸電極4と前記被覆5は、必ず接触するようになり、電気的な接続を確実に行うことができる。

【0017】本願の発明は、上述の構成や方法に限らず、その他この精神に逸脱することなく種々の変形が可能である。

【0018】

【発明の効果】

請求項1に対応する効果：光ファイバの外径と同程度かそれより小さい受光領域と前記受光領域に対した凸電極とからなる受光素子をアレイ状に配置した受光素子基板に、光ファイバの端面及び外周部の一部に導電性の被覆を施した光ファイバを近接し、前記凸電極と前記導電性の被覆を接触させることで、光ファイバと光素子とからなる光モジュールの性能の低下をさせることなく、位置合わせの精度を緩和することができ、かつ、光結合と受光素子電極の取り出しを同時に行えるので、作製の容易な光モジュールを提供することが可能となった。

請求項2に対応する効果：電極が施してある溝を有する平板基板の該溝に前記光ファイバを固定することで、次段の電気回路との接続とが容易になり、安価な光モジュールを提供することが可能となった。

請求項3に対応する効果：前記受光領域に防護凸部を有したので、前記凸電極の導電性の部材や、接着剤が光ファイバのコア部と受光領域との間に浸入するのを防止することが可能となり、歩留まりのよいモジュールを作製することが可能となった。

請求項4に対応する効果：光ファイバに対し、受光素子基板を加圧して配置することによって、凸電極と導電性の被覆とが確実に接触するため、電気的な接続を確実に行うことが可能になった。

【図面の簡単な説明】

【図1】 本発明の実施の形態による光モジュールの要部概略図である。

【図2】 本願の他の発明の実施の形態による光モジュールの概略図である。

【図3】 本願の更に他の発明による実施の形態を説明するための要部概略図である。

【図4】 本願の更に他の発明による実施の形態を説明するための側面図である。

【図5】 従来の光ファイバと受光素子との光結合の一

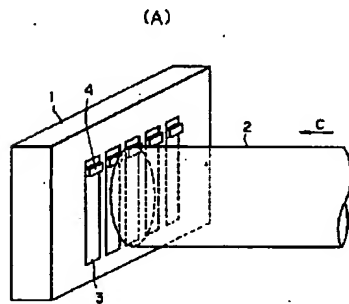
例である。

【図6】 従来の光ファイバと受光素子との光結合の他の例である。

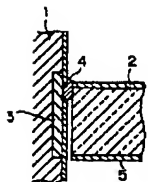
【符号の説明】

1…受光素子基板、2…光ファイバ、3…受光領域、4…凸電極部、5…導電性の被覆、10…L字型の金属部材、11…基板、12…ファイバ保持部材、13…ワイヤーボンディング、14…V溝の電極、15…防護凸部、16…弾性に富む導電性部材。

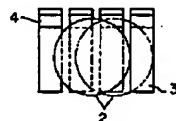
【図1】



(B)

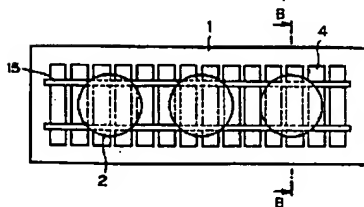


(C)

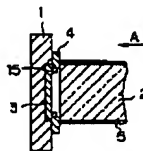


【図3】

(A)

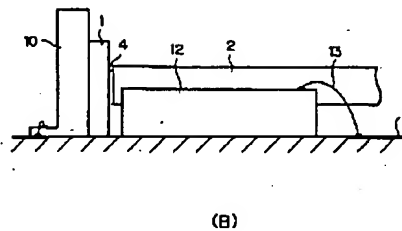


(B)

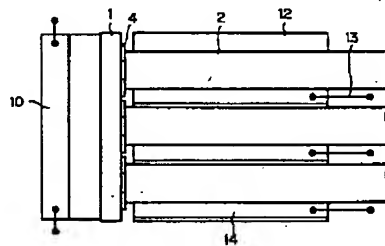


【図2】

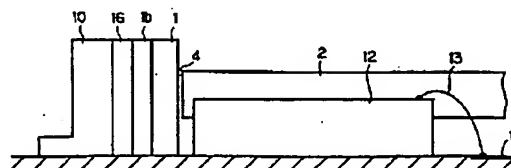
(A)



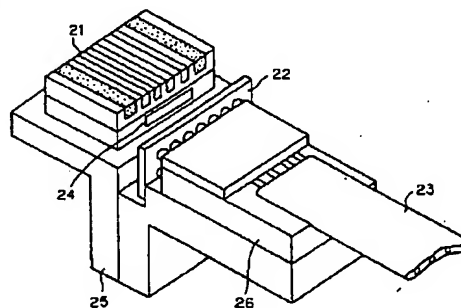
(B)



【図4】



【図5】



【図6】

